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UNION OF SOUTH AFRICA

DEPARTMENT OF MINES

THE GOLD OCCURRENCES SOUTH-WEST OF PIETERSBURG

BY

J. WILLEMSE, M.Sc., Ph.D.

PUBLICATION OF THE GEOLOGICAL SURVEY DIVISION

Printed in the Union of South Africa
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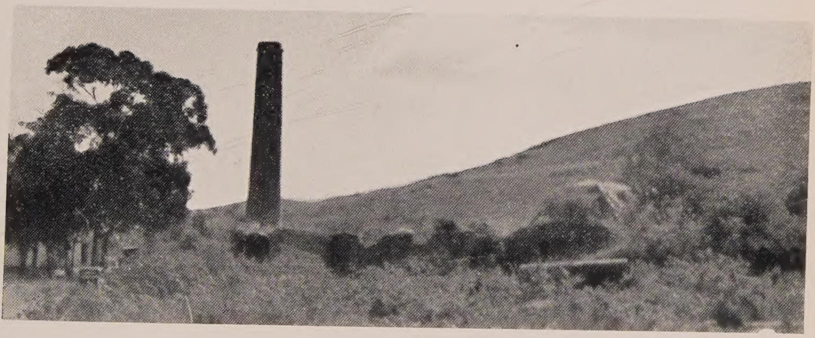
PLATE I.



Old Chimney on Eersteling.

THE GOLD OCCURRENCES SOUTH-WEST OF PIETERSBURG.

ABSTRACT.

Gold occurs in quartz reefs and mineralised zones in rocks belonging to the Swaziland system and in the Old Granite not far from the contact. A concentration of ore is associated with certain structural features such as the junction of two reefs or a bend in a reef. In addition, gold is found in alluvial deposits.

According to available records the area has produced more than 30,000 ounces of fine gold during the past 32 years.

I.—INTRODUCTION.

Location and Topographic Features.

The area at present recognised as of economic importance lies solely within the magisterial district of Pietersburg. The same geological formations, however, extend towards the south-west into the Potgietersrust district. The farm Eersteling No. 87, which is the property drawing most attention at present, is about 23 miles by road from Pietersburg and about half this distance from Marabastad, the nearest railway station. The region is served with good roads and is easy of access.

This portion of the Pietersburg district falls within the Highveld of the northern Transvaal and has an average altitude of more than 4,000 feet above sea level. The mild and healthy climate is certainly an asset to the region and should lend greater encouragement to mining development there, than, for instance, in the Lowveld where similar gold deposits are found.

Due to a great variety of rock types the scenery is far from monotonous. In the south the Black reef series forms a prominent escarpment overlooking the country towards the north. This escarpment effect of the Black reef series is considerably diminished in the western part of the region because the rocks of the Swaziland system and the Old Granite here give rise to broken mountainous country. From Button kop, forming part of the escarpment, an open view can be obtained of the country towards the north. The low greenstone hills in the vicinity of the farm Eersteling No. 87 occur in the foreground, followed by the conspicuous ridges of Mount Maré. The latter is formed of banded ironstone and other sedimentary rocks belonging to the Swaziland system. In the distance the flat-lying granite country about Pietersburg is broken in the east by low granite hills or by the development of an occasional vein quartz ridge, such as Wit kop.

With regard to the water-supply of the area, the average annual rainfall is about 25 inches and there are a number of permanent streams. All the plants treating ore on the farm Eersteling No. 87 are supplied with water from the mines. In the rainy period of February, 1937, most of the work underground had to be temporarily closed down on account of the great influx of water, the mineralised zones in the schist apparently acting as underground water channels.

In Mount Maré proper the mines are practically dry. At one time the ore was actually transported by donkey wagon for a distance of more than 2 miles to the battery which is situated on the banks of a permanent stream. The dryness of these mines is due to their situation high up on the dip slopes of the hills. It is very likely that, when boreholes are sunk in the low-lying parts to the south of the range, strong supplies of water will be struck, as here the Old Granite is in contact with rocks of the Swaziland system. In addition, there are numerous poorts which are suitable for the construction of dams. The possibility is that the highly schistose rocks may not retain the water and on these grounds care should be taken that an impervious shale zone is chosen to form the bottom of the reservoir. Even if ore had to be transported to a stream, no great expense would be incurred as the gradient is uniformly downhill all the way. With mechanical transport a minimum amount of energy would be required.

HISTORY.

The farm Eersteling No. 87 has acquired historical significance as the property on which the first reef gold was discovered in South Africa in 1871 by Messrs. Button and Pigg. It is also said that alluvial gold was found on this farm as far back as 1868.

In connection with the exploitation of the deposits in the early days a chimney some 90 feet high was erected in the vicinity of the occurrences (cf. Plate I). Although built in 1875 the structure is still in good condition; the boilers connected with the chimney, however, were never fired. In view of its historical importance, the site on which it stands was donated to the Union Government, and has recently been proclaimed as a national monument together with the neighbouring " First Gold-crushing Site ". In the Geological Museum in Pretoria a large boulder originally from Eersteling is displayed. It weighs approximately 1,100 ℔. and was used in the early days to crush the ore.

From the time of discovery of the gold until 1881 the property was worked to a considerable extent. One shaft is said to have attained a depth of 350 feet (1, pp. 198 and 199).[1] Since the war in 1881 when the machinery was demolished, work was done intermittently until about 3 years ago. At present mining is being revived on a number of old properties and prospecting is being undertaken in other localities.

PREVIOUS WORK.

Compared with other gold-bearing regions of an analogous nature in South Africa very little reference in the literature is found to the geology of Mount Maré or its environs. On the other hand probably one of the most detailed petrographic studies ever carried out on rocks from South Africa was done before 1885 by Joseph Götz on material collected from the neighbourhood of the farm Eersteling No. 87 and Marabastad. (2, pp. 110–177).

A reconnaissance survey of Mount Maré and its vicinity was done by A. L. Hall during 1908. He also reported on the geology (3, pp. 61–102) and, in his subsequent works on the Murchison range and the Barberton district, he drew attention to the close correspondence between the rocks of these regions and those of Mount Maré.

GENERAL STATEMENT.

The rocks most widely represented in the area under consideration belong to the Swaziland system which is the oldest geological formation in South Africa. They consist of greenstones, which are massive fine-grained greenish hornblende-bearing rocks, and basic schists (chlorite, talcose and serpentinous varieties). This assemblage is considered to be altered igneous material, and associated with it in certain sections are sedimentary rocks such as shales, sandstones, conglomerates, and banded ironstones.

The Swaziland system, which originally had a very widespread distribution, was intruded by the so-called Old Granite. The emplacement of this igneous body, assumed to have taken place at a considerable depth below the then existing surface of the earth, caused the alteration of the invaded rocks to such an extent that their original features were largely obliterated. The hornblende, chlorite, and talc all owe their origin to the influence of the invading magma, while in the original sedimentary rocks andalusite, chloritoid, sericite, tourmaline and other minerals in all probability developed as a result of the same cause.

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[1] The figures in brackets refer to the literature at the end of the paper.

The schistosity characterising so many of the rocks of the Swaziland system, and the tilting of the formations, as indicated by the general steep southerly dip of the sedimentary rocks, are also probably related to the intrusion of the granite.

After the igneous activity had died down, a very long period elapsed during which erosion caused the removal of extensive areas of Swaziland rocks. Ultimately the granite reached the level of the surface, only comparatively small remnants of the once extensive pre-granite rocks being left behind in a " sea " of granite. One example of such an " island " is represented by the rocks of the Swaziland system under discussion.

The Transvaal system, with the Black reef series as its basal member, was laid down on the denuded surface of the ancient rocks and at present demarcates the area on its southern side. The escarpment to which it gives rise is formed chiefly of quartzites with subordinate conglomerates.

A transverse fault extending from the vicinity of Potgietersrust at least as far as Mount Maré affected both the Transvaal system and the older rocks.

Gold deposits occur in the Swaziland system and in the Old Granite not far from the contact. In a few cases they are closely associated with bends in the contact between the granite and the schist. During the final manifestations of igneous activity associated with the emplacement of the Old Granite, fissures formed in the Swaziland system and in the granite. These were filled predominantly with barren vein quartz, but occasionally they were reopened and sulphides, gold, and other minerals were deposited in them. The metallisation also extended into fracture zones in the schist, so that ore minerals need not necessarily be associated with large quantities of quartz.

On becoming exposed to the surface the metal-bearing portions were oxidised, giving rise to friable iron-stained zones and quartz reefs, which in accordance with the nature of their formation possess very variable quantities of gold.

A study of the deposits reveals that a primary enrichment is controlled by structural features such as curves in the reefs and junctions or intersections of reefs.

Proceeding to depths beyond the zone of oxidation, it is possible that the gold will become less free milling but the absolute values are not likely to disappear in the sulphide zone. On the other hand the deposits vary considerably along their strike so that no consistency is to be expected on following them to lower levels.

Alluvial gold is found in gravels along the streams and depressions in the parts lying lower than the reef occurrences, from which it was undoubtedly derived. High values are associated with thin quartz leaders which acted as barriers in the streams which transported the gold.

II.—DESCRIPTIVE GEOLOGY.

The present report deals mainly with the pre-granite rocks south of Pietersburg. As soon as extensive areas of other formations were encountered the mapping was discontinued.

The region to the north of latitude 24° 0′ S., shown on a portion of the 1/100,000-scale map at the end of the paper, was surveyed by Dr. B. V. Lombaard during 1934. Although the quartz veins are indicated on the field sheets of the entire area covered by this small scale map, they have not been shown on the generalised copy accompanying this paper. Two very prominent vein quartz ridges occur on the farms Weltevreden No. 140, where it is known as Wit kop, and on Bloemhof No. 352. The areas in the vicinity of Mount Maré and the farm Eersteling No. 87 represented on the maps (Plates No. VI and VII) were surveyed during 1937 on scales of 400 and 200 Cape roods to the inch respectively, and subsequently photographically enlarged to the natural scales of 1/50,000 and 1/25,000 respectively.

Table of Geological Formations.

Surface drift.	
Intrusive rocks..................	Quartz porphyry. Pyroxenite (Bushveld igneous complex). Basic intrusions. Old Granite.
Black reef series and certain rocks which may be older............	Quartzites, grits, conglomerates, lavas and tuffaceous rocks.
Swaziland system................	Para-rocks and Ortho-rocks.

THE SWAZILAND SYSTEM.

As can be seen from the map (Plate V) the pre-granite rocks occupy an area of very irregular outline partly due to the irregular contact of the granite and partly to the influence of faulting.

The true identification of many of the rocks is only possible by means of a detailed petrographic study. As the present account was written before such an investigation could be carried out, it is bound to be inconclusive in many respects. The task of classifying some of the rocks according to their mode of origin is especially difficult.

As a result of intermittent lava-flows and sedimentation, there is a close association between original igneous and sedimentary rocks. This makes it impossible to classify them into a sedimentary and an igneous group implying age differences and comparable respectively with the Moodies and the Jamestown series of the Swaziland system. At present we are unable to recognise a group of igneous rocks, contemporaneous with the sedimentary rocks of the Moodies series, which can be entirely excluded from the Jametown series. Consequently in the scheme of the geological formations a division is made only into para-rocks (metamorphosed sedimentary rocks) and ortho-rocks (metamorphosed igneous rocks).

Para-rocks.

The prominent topographic features of the neighbourhood of Mount Maré and the Yzerberg are due to ridges formed of original sedimentary rocks. The trigonometrical beacon on the farm Snymansdrift No. 4 has an altitude of 5,575 feet. The highest ridges of Mount Maré rise on an average 1,000 feet above the level of the plains.

TABLE I.—*Section from south-east to north-west along the boundary fence of the farms Zandrivier No.* 139 *and Snymansdrift No.* 4.

1.	Coarse arenaceous sediments. (Uppermost boundary not exposed)	400 feet.
2.	Shales sometimes altered to chloritoid and andalusite schists together with interbedded arenaceous and ferruginous beds	1,600 feet.
3.	Dark and light-coloured sheared grits forming the crest of the southernmost ridge of Mount Maré	75 feet.
4.	Sheared conglomerates, stained red on weathered surfaces, with numerous lamellated quartz fragments. The middle banded ironstone horizon, at this locality about 7 feet thick, occurs 120 feet above the base of these beds and has a sharp contact with the enclosing rock	400 feet.
5.	Green schists in the depression between the two main ridges of Mount Maré	1,600 feet.
6.	Lowermost group of Banded Ironstones.	
	Banded ironstone . . . about	100 feet.
	Green schist	70 feet.
	Banded ironstone	10 feet.
	Green schist	200 feet.
	Banded ironstone interbedded with schist	20 feet.
	Green schist	60 feet.
	Banded ironstone	160 feet.
	Green schist	60 feet.
	Banded ironstone with only a few thin ferruginous bands and consequently producing a "white band" effect at a distance	30 feet.

The accompanying tables (pp. 11, 13) illustrate the diversity in nature of the para-rocks and their intimate association with the basic schists which are considered to be ortho-rocks. The values for the thickness of the beds were obtained from measurements in the field and from calculations from the map. The three sections of the uppermost beds on Hollandsdrift No. 113 (given in Table II, page 13) demonstrates the great variation in thickness of these beds. No two sections taken some distance apart anywhere in Mount Maré are likely to show corresponding values. It is not strange, therefore, that the values given by Hall are very different from those in this report.

Some of the para-rocks according to their mineral content belong to comparatively deep zones of metamorphism, whereas others in close contact show no sign of advanced alteration.[1]

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(1) The nature of the metamorphism will not be discussed; it is considered to fall outside the scope of this report.

(*a*) *Banded Ironstones.*—In Mount Maré three horizons can be recognised, the central horizon being discontinuous. An additional one is developed locally here and there, as on the farm Zandrivier No. 139. The latter, as well as the most south-easterly banded ironstone (indicated on the map on the farm Snymansdrift No. 4) seems to represent quartz veins and irregular quartz stringers in the schist rather than true banded ironstone. Although the banded ironstones, in general, are conspicuous, they have little importance as " markers " on account of their sporadic development and their occurrence on several horizons. The Lowermost Banded Ironstone zone, for instance, consists of two prominent bands with other subsidiary bands. On following these bands along their strike from north-east to south-west, the uppermost member of the lowest zone especially, emerges and disappears as if affected by a number of cross faults almost parallel to the strike of the beds. In the vicinity of the trigonometrical beacon on Snymansdrift No. 4, the uppermost band has disappeared completely. The lower band, however, continues while another still lower becomes so prominent that the double character of the zone is retained.

The banded ironstone on the farm Hollandsdrift No. 113, representing the uppermost of the three main horizons in Mount Maré, is much more contorted than any of the others (cf. Plate II, photo 1, facing page 12). This feature is also displayed but not so conspicuously, by the same rock of the Yzerberg.

A pronounced inconsistency along the strike was also observed in the banded ironstones to the north of the Yzerberg and to the north of the trigonometrical beacon on the farm Uitkyk No. 854. Two main zones of banded ironstone in the latter locality have been indicated on the map. Generally, each zone consists of two layers of banded ironstone interbedded in basic schist, but locally several thin bands may be encountered.

The southernmost of these zones is noteworthy in that, north of the trigonometrical beacon on Uitkyk No. 854, its dip changes in direction from north to south, whereas the arenaceous rocks of the Swaziland system retain their normal strike and orientation. The last indications of this zone towards the west are two thin bands close to the overlying Black reef series. Towards the east the same zone gradually approaches the arenaceous rocks until finally it immediately underlies them. Among the coarse sediments at this locality occur banded cherts very much resembling the banded ironstone and consisting of alternating bands of dark-grey and light-coloured chert.

The results of the mapping of the banded ironstones to the north-east of Mount Maré and those obtained by Dr. Lombaard to the south of Pietersburg, further show their irregularity in occurrence. It must be pointed out, however, that on the farm Roodepoort No. 88 and on the eastern portion of Zandrivier No. 139, two zones of banded ironstone, although ill-defined, can still be recognised. This suggests that the two lowermost zones continue northward beyond Mount Maré.

Banded ironstones are generally considered subaqueous chemical deposits and not detrital sediments, but their origin is not yet fully understood. It would appear as if the zones in which they occur persist along considerable distances of strike but that the individual bands are often very discontinuous.

(*b*) –*Sediments of Detrital Origin.*—These are represented by coarse sandstones (generally originally felspathic and now often altered to quartz-mica schists), conglomerates, and shales.

PLATE II.

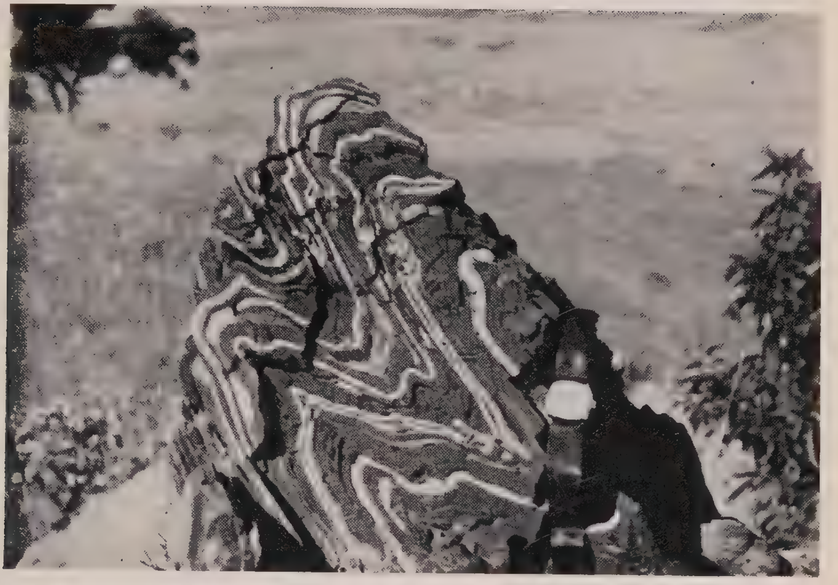

PHOTO 1: Contortions in Banded Ironstone.

PHOTO 2: Coarse Conglomerate on Rietvlei.

Table II.

SECTION AT RIGHT ANGLES TO STRIKE OF PARA-ROCKS ON THE FARM HOLLANDSDRIFT NO. 113.

West....½ mile.............Central.............⅚ mile.........East.

	No outcrops.	No outcrops.	Mostly greenish schistose rocks also shales. In one place a small outcrop of sandstone.
	No outcrops.	Conglomerate.	Conglomerate with numerous pebbles of banded ironstone.
	No outcrops.	Shaly rocks Coarse conglomerate Black phyllite } thickness very irregular.	Wanting.
Sandstone	162 feet.	Sandstones locally conglomeratic 100 feet.	
Coarse conglomerate	90 feet.		
Sandstone	81 feet.		
Shales	96 feet.	30 feet.	
Sandstone	60 feet.	15 feet.	
Conglomerate sometimes sheared with ferruginous shales in places	45 feet.		
Greenstone	450 feet.	Contains a silicified tuffaceous zone in its central part forming a ridge. 470 feet.	350 feet.
Conglomerate containing amongst others pebbles of basic schist, banded ironstone and granite	2,000 feet.	1,700 feet.	400 feet.
Sandstone	400 feet.	400 feet.	400 feet.

In the west, in the neighbourhood of the trigonometrical beacon on the farm Uitkyk No. 854, a conspicuous mountain ridge (known as Mount Robert), rising some 1,400 feet above the low-lying country, is formed of coarse sandstones and quartzites with occasional pebble beds. On the same farm prospecting work has been carried out on some of the pebble bands but without results. The conglomerates are too intimately associated with the sandstones to permit their being separately indicated on the map. They occur most abundantly towards the central portion of the sedimentary rocks. Very often the arenaceous beds in this area exhibit a pronounced shearing and the extraordinarily great thickness attained by them towards the west, where they are unconformably overlain by the Black reef series, may perhaps be due to strike faulting, although there is as yet insufficient evidence to support such a view. Just south of where this prominent arenaceous zone disappears underneath the Black reef series, irregular arenaceous rocks occur, intimately associated with greenstones. They have not been separately indicated on the map.

On the farm Weenen No. 253, just north of the main road leading to Pietersburg, phyllitic rocks occur which are probably of sedimentary origin. There are also arenaceous varieties but these seldom crop out and are closely associated with a granite occurrence so that it is somewhat difficult to tell the nature of the rock from the weathered material. A thin band of a fine-grained quartzite and occasionally also conglomerates occurs in the ortho-rocks on the farm Zwartkrans No. 49.

North of the farm beacon on Yzerberg shaly-looking rocks are to be found below the banded ironstones, and further north a zone of similar phyllites, dark-grey to black in colour, attains a comparatively great thickness. Towards the west more or less on the same horizon an altered grit, closely associated with a banded ironstone, forms a conspicuous ridge. On the farm De Berg No. 348 the rocks resemble hornfelses and exhibit well-developed bedding planes on weathered surfaces.

Arenaceous beds are found at two distinct horizons in the section to the north of the Yzerberg. The upper one, which is correlated with similar sedimentary rocks of Mount Robert, consists of two sandstone beds separated by a conspicious conglomerate zone. The latter should sometimes be designated a boulder bed in view of the size of its components. It weathers into large massive boulders (cf. Plate II, photo 2, facing page 12), and, especially on the farm Hollandsdrift No. 113, gives rise to low rounded hills.

Towards the west in the section to the north of the Yzerberg, the grit or sandstone underlying this conglomerate can be separately mapped. To the west of the transverse fault that affects these beds in the east there are so many conglomerate bands in the sandstone that it is not possible to draw definite boundaries between them. The upper sandstone beds thin out towards the east. In the west where this sedimentary zone ends against the granite it has been disturbed, presumably by a small thrust fault.

The lower sedimentary horizon in the Yzerberg section is a fine-grained quartzite especially well exposed on the boundary fence between the farms Rietvley No. 94 and Rotterdam No. 32. In an easterly direction its outcrops become less conspicuous. In one locality a banded ironstone is found for a distance of several hundred yards along the base of this horizon.

The relationships of the sedimentary rocks on Hollandsdrift No. 113 are explained in Table II. Here, again, we encounter a prominent conglomerate zone, which can probably be correlated with the same rock type of the Yzerberg

PLATE III.

PHOTO 1: Southern view of Mount Robert consisting of arenaceous rocks belonging to the Swaziland System.

PHOTO 2: Pseudostratification exhibited by the pyroxenites on Uitloop.

section. The pebbles are large, sometimes more than 6 inches in diameter, and consist of a great variety of rock types: banded ironstone and schist play an important role while granite pebbles were also observed.

A great variety of conglomerates and phyllites occur towards the uppermost zones of the sedimentary rocks on Hollandsdrift No. 113, before the highest banded ironstone is reached.

The lowermost sandstone horizon is the only one which bends towards the north-east and continues into the farm Snymansdrift No. 4. There, and particularly on Zandrivier No. 139, this sandstone overlies an exceedingly variable assemblage of rocks of detrital origin. These rocks build the southernmost ridge of Mount Maré and consist of shales with interbedded quartzites and phyllites. The middle banded ironstone occurs towards the base of these rocks in a highly sheared ferruginous conglomerate. As the matrix around the drawn-out pebbles is very fine-grained and phyllitic in nature, it is doubtful whether this rock is actually of sedimentary origin. The argillaceous beds vary from unaltered shales to highly metamorphosed chloritoid and andalusite schists. The chloritoid schists are well exposed on Zandrivier No. 139 on the sides of two gullies running parallel to the boundary fence between this farm and Snymansdrift No. 4. The chloritoid can usually be recognised in great abundance in hand specimens. The andalusite occurs in a knotted schist, generally bluish in colour, which may sometimes be confused with similar quartz schists forming the conspicuous ridge on the Zandrivier Mynpacht. These also have a knotted appearance on the weathered surfaces but do not necessarily contain andalusite.

The sedimentary rocks under discussion disappear below the surface just before the main road from New Smitsdorp to Marabastad is reached. Other arenaceous rocks, however, occur towards the north and form a conspicuous pointed hill south of the Kuschke School Farm. The same rocks were also encountered in a borehole close to the school. In a creek cutting through them they exhibit a very pronounced jointing, dipping at a low angle towards the north-west, while elsewhere they have a schistosity in conformity with that of the other schists of Mount Maré. The ridge formed of the lowermost zone of banded ironstones of Mount Maré ends abruptly against these sandstones behind the school. In one locality the actual contact of the two rock types could be studied, the sandstone appearing to have been fused with the banded ironstones. The contact is considered to be tectonic in origin.

In the bed of the stream flowing towards Marabastad station from Wildebeestfontein No. 89, and also for some distance to the east of it, sandstone with conglomerate lenses, the latter sometimes up to 18 feet in thickness, again occurs. When followed along the strike they are replaced by basic schists.

Phyllites and sheared conglomerates, which may be of sedimentary origin, are associated with the banded ironstones on the farm Palmietfontein No. 101.

Ortho-Rocks.

Massive types and schistose varieties are included amongst the ortho-rocks. Those associated with the sedimentary rocks of Mount Maré and those further to the north-east are mostly schistose, whereas those from the farms Eersteling No. 87 and Turffontein No. 105 are much more granulose forming typical greenstones. Towards the southern boundary of the occurrences, i.e., on Vrischgewaagd No. 100 and Rietfontein No. 70, schistose varieties again predominate.

Although these rocks have only received a cursory petrographic examination by the writer, it would appear that, towards the north-east of the area mapped, they are mainly ultra-basic varieties, whereas the others are more gabbroic in composition.

In the Mount Maré region, especially on the farm Hollandsdrift No. 113, many greenish schists occur closely associated with the sedimentary rocks. Some of them weather to look like ferruginous shales but when fresh are greenish. On the map they have been grouped with the ortho-rocks, although future research may lead to the identification of some of them as greywackes and allied varieties. The presence of structures resembling amygdales and the intimate connection between these schists and true sedimentary rocks suggest that they are basic lavas containing occasional lenses of sedimentary material.

On the farms Palmietfontein No. 101 and Roodepoort No. 88 talcose schists and serpentinous varieties are often encountered. Not far from the contact with the granite, irregular bodies of calcareous rocks are developed : sometimes they are conspicuously greenish in colour. These rocks almost certainly represent hydrothermal products obtained from the alteration of the ultra-basic types.

The granulose varieties from the neighbourhood of the farm Eersteling No. 87 include amphibolites, close to the granite contact, which correspond no doubt to the epidiorites of Rhodesia. They are dark fine-grained rocks resembling diabase but unlike it in their mode of fracturing and weathering into rectangular blocks, not spherical boulders. Some of these may be dyke-like intrusions in the Swaziland system. Possibly the diabase dykes indicated on the map, especially those on the farm Waterval No. 211, are such epidiorites.

In the Potgietersrust district the ortho-rocks are variable, probably serpentinous varieties predominating. On the farms Uitkyk No. 854 and Driefontein No. 294 asbestos has been searched for, and on the latter farm a pocket has been taken out to a depth of 10 feet. The vein at the end cf the excavation is about 1 foot thick and its original length was about 36 feet.

The fine-grained aphanitic character of the basic rocks in general gives place in a few localities to a comparatively coarse hypidiomorphic grain development. These rocks, *original pyroxenites*, occur on the farm Turffontein No 105 as striking dyke-like bodies in the pre-granite rocks. The pyroxenes are largely uralitised and one may safely assume that these pyroxenites came into their present position prior to the emplacement of the granite.

There is also a dyke of a *syenitic rock* in the pre-granite rocks on Eersteling. It does not give rise to any conspicuous topographic features and occurs on the side of a hill overlooking Pienaars' mine. The rock is coarse-grained, some of the felspar crystals attaining a length of 2 cms. Even in hand specimens the bulk of the substance between the felspars can be seen to consist of epidote. The author believes it to be of Swaziland age.

One of the foothills of the escarpment of the Black reef series, to the south of Button kop, is in the form of a conspicuous ridge consisting of a fine-grained greyish rock. It has a slightly talcose feel and an occasional clear quartz grain can be recognised in an otherwise dull matrix. With the aid of the microscope it can be seen that the rock represents an *original quartz porphyry*, in which the quartz crystals are still retained, whereas the felspars and the groundmass are completely sericitised. The original outline of the felspar crystals can still be recognised in a few cases. Rocks of an analagous nature were also encountered in small occurrences in the Potgietersrust district.

On the farms Waterval No. 211, Vrischgewaagd No. 100 and Rietfontein No. 70 there are so many xenolithic occurrences of schist in the granite and so many tongues of granite in the schist that the line on the map indicating the contact is arbitrary.

THE BLACK REEF SERIES AND CERTAIN ROCKS WHICH MAY BE OLDER.

The Black reef series was mapped in order to indicate the boundaries of the Swaziland system and also to learn as much as possible about the fault which affects both the Transvaal system and the older rocks in this region. A few phenomena of general stratigraphical importance were incidentally recorded during this survey.

The sedimentary rocks, of which the series is composed, consist of coarse and fine-grained quartzites and conglomerates. Although there is a general decrease in the thickness of these beds towards the west, their areal extent is considerable where they overlie the arenaceous rocks of the Swaziland system. This is largely due to the fact that they form extensive dip slopes.

The quartzites of this series present a much more recrystallised appearance than the arenaceous rocks of the Swaziland system. This is due to the much higher silica content of the former compared with the latter.

The conspicuous escarpment, of which Button kop forms a part, consists of rocks belonging to this series. Below the cliffs of the mountain range on Rietfontein No. 70 and also on Eersteling No. 87 an amygdaloidal basic lava was found. It occurs on the slopes about 100 feet or so below the bottom of the cliffs and is underlain by a coarse-grained quartzite, which varies in colour from dark to light. On Rietfontein No. 70 a fine-grained, probably tuffaceous, sediment was found interbedded in the lava. It exhibits well-developed cross-bedding. The lava itself is about 100 feet or more in thickness but the sediments associated with it, forming the slopes below the steep cliffs, give the particular assemblage a total thickness approaching 200 feet in places. Just north of the quartz porphyries, associated with the pre-granite rocks on Eersteling No. 87, the lavas could not, however, be located. The rocks exhibiting an amygdaloidal texture in this part belong to the Swaziland system. Below Button kop the lava is well exposed but from here immediately towards the west it is not again encountered. The horizon is almost certainly represented by a coarse conglomerate with many affinities to an agglomerate found at the base of the Black reef quartzites outcropping just west of the farm beacon common to Eersteling No. 87, Rietvley No. 94 and De Berg. South of the main road to Pietersburg in the vicinity of Yzerberg there is no sign of volcanics; only occasionally, greenish shaly rocks occur near the base of the Black reef series along this part of the escarpment. In the mountainous country on Weenen No. 253 the presence of the lava has also been established. Here it is only about 20 feet thick.

Generally the lavas and their associated rocks appear conformable with the Black reef series, so that the impression gained is that these beds constitute an integral part of the series. Nevertheless they cannot definitely be assigned to this group, as they were encountered only along a small distance of strike and we have as yet no information about their distribution and relationships towards the east of the area mapped. Volcanics and sedimentary rocks of a similar nature in the eastern Transvaal (in the vicinity of Sabie) are unconformable with the Transvaal system, according to recent investigations by members of the Geological Survey. They are definitely considered to belong to an older formation. It is possible that the rocks in the Pietersburg district belong to the same category.

INTRUSIVE ROCKS.

The Old Granite.

On the whole the granite is sufficiently well exposed for the boundaries to be drawn fairly accurately. To the south of Mount Maré, however, the surface soil in the flat-lying country is thick and the position of the contact is accordingly uncertain. The writer has indicated it somewhat close to the mountain, due to the fact that at the foot of the hills a decomposed pegmatite is exposed in a water furrow. The hilly country on the farm Hollandsdrift No. 113 ceases so suddenly that, unless the phenomenon is due to the "coming-in" of the granite, it is difficult to explain.

Usually the Old Granite displays an intrusive relation to the basic schists but on the farms Turffontein No. 105 and Hollandsdrift No. 113 the contact is faulted. The only reasonably accurate method of deducing the exact position of the fault is from the nature of the soil. In two places this contact is actually exposed to within a few yards. The best one to study is in the bed of the creek which runs more or less parallel to the boundary fence between the farms Turffontein No. 105 and Hollandsdrift No. 113, about 600 yards west of the fence. The granite, being reduced to a highly lamellated rock, appears to have suffered the effects of shearing much more than the schist. The other exposure is just west of the main stream running through the farm Turffontein No. 105. Strong springs occurring in the bed of the stream in this part are almost certainly related to the contact.

The relation of the granite to the intruded rocks on the farms Waterval No. 211, Vrischgewaagd No. 100, and Rietfontein No. 70 has already been referred to (cf. page 17). The granite occurrences in the vicinity of the north-eastern beacon of Eersteling No. 87 have very irregular contacts, the granite magma thoroughly permeating the schists. All the granite veins could not be inserted on the map.

Generally the proximity of the contact has not noticeably affected the texture of the granite. On the farm Driefontein No. 294 and more particularly on Zwartkrans No. 49 in the Potgietersrust district, however, small occurrences of granite and an offshoot from the main granite body assume the character of a quartz porphyry.

On Landsberghoek No. 280 and Driefontein No. 294 the granite gives rise to very rugged country, characterised by high rounded ridges. The rock is generally rather reddish in colour, but on the farm Uitloop No. 291, close to the pyroxenites, it is often very light-coloured. On this farm a small detached occurrence yields a rock which has lost many of its original features as a granite, in that it is a fine-grained pinkish sericite schist. The present opinion is that this rock is an original aplitic variety of the Old Granite which has suffered alteration as a result of the emplacement of the Bushveld igneous complex, but a more detailed study may prove this incorrect.

Basic Intrusions.

Reference has already been made to the fact that on the farm Waterval No. 211 the basic intrusions sometimes resemble the pre-granite rocks. Elsewhere they are more distinct and generally assume the dyke-like habit of intrusion.

In the comparatively homogeneous Old Granite, as for example to the west of Pietersburg, Dr. Lombaard found the dykes to follow a general north-east to south-westerly direction. When once this fact has been established the dykes in the pre-granite rocks and in the contact regions can be seen to possess a tendency to conform to this direction. Often, however, the nature of the enclosing rock has a marked influence on the orientation of the intrusion. On Zandrivier No. 139, to the north of Mount Maré, one prominent dyke in the granite trends at an angle to the planes of schistosity in the pre-granite rocks and, although the dyke rock crops out up to the contact, it does not enter the schist. In the latter another body appears to strike in an altogether different direction, being more or less parallel to the strike of the schists.

In Mount Maré a few poor outcrops have been interpreted as representing a body of very irregular shape.

To the north-east of the old Freda mine there are many small occurrences which could be referred to as stringers of diabase in the schists.

On the farm Hollandsdrift No. 113 a number of gaps occur in the ridge formed of the uppermost zone of banded ironstones. In a few cases they were found to be due to dykes but in some no outcrops of any dyke rock could be found.

On the same farm a dyke running at an angle to the structure of the country has caused the underground water to rise to the surface, and as the catchment area is very extensive the supply of water is exceptionally strong.

In the Black reef series on Weenen No. 253 a few small sills were encountered but they do not continue far along the strike.

Freshly broken surfaces of the dyke rocks inspected by the writer were found to correspond to diabases rather than dolerites. The farm Langgenoeg No. 1977 is the only locality where one dyke has been found to cut another. The younger of the two dykes strikes in a more easterly direction than the other and being only about 6 feet wide is very fine-grained.

Although generally evenly fine-grained, in a few cases the diabases are porphyritic, the saussuritised felspars forming phenocrysts up to 2 cms. in length.

The few features characteristic of the basic dykes observed during the present survey indicate that a detailed study of this rock group may yield interesting results.

Pyroxenite (Bushveld Igneous Complex).

On the farm Uitloop No. 291 in the Potgietersrust district an offshoot from the Bushveld igneous complex is in contact with the Old Granite. The occurrence gives rise to a conspicuous hill with its highest point at the trigonometrical beacon on this farm and it provides us with a magnificient example of pseudostratification, the dip being at an angle of approximately 15 degrees towards the south-west (cf. Plate III, photo 2, facing page 14). The entire body, as far as its composition is revealed on the eastern flank, consists of pyroxenites, although a few boulders of spotted norite were also found at the foot of the hill.

In one of the creeks the contact between the weathered pyroxenite, the basic schists of the Swaziland system and the Old Granite is exposed but it presents no special features.

Quartz Porphyry.

Probably the youngest rock in the area under consideration is a quartz porphyry on the farm Rietfontein No. 70. It forms a prominent dyke not far from the eastern boundary of the farm. At a distance the light-coloured outcrops resemble granite exposures.

In hand specimens the rock has a very fresh appearance and consists of felspar phenocrysts on an average 0·5 cm. in cross section and vitreous quartz grains in a dull aphanitic matrix.

The rock is closely associated with diabase and it is not unlikely that its magma has risen along the same fissure as that of the basic rock with the result that diabase occurs first on one side of the quartz porphyry dyke and then on the other.

For a distance of roughly half a mile towards the west of the portion of the dyke mapped, it is not exposed ; but further on it reappears and the composite nature of the intrusion of the porphyry with regard to the diabase is again indicated.

III.—GEOLOGICAL STRUCTURE.

The rocks of the Swaziland system are surrounded practically on all sides by the Old Granite with a very irregular contact, which is partly due to faulting but mostly to an intrusive relation. In the south the boundary is formed by the Black reef series, which overlies the ancient rocks unconformably and, forming part of the northernmost rim of the Bushveld igneous complex, has a low dip towards the south.

Towards the west the Swaziland system has a general east-westerly trend, the sedimentary rocks having a steep southerly inclination. East of Yzerberg a transverse fault affecting the Black reef series south of Mount Robert, and therefore post-Transvaal in age, plays an important rôle, displacing the chief sedimentary horizon of the Swaziland system for a distance of about 8 miles, i.e., to the vicinity of Mount Maré. The clearest evidence that the rocks of the environment of Yzerberg actually continue into Mount Maré is provided by the conglomerate zone in the sediments. The banded ironstones are not reliable "markers" in this part in that they occur on several horizons and do not persist along the strike.

The general east-westerly trend is also shared by the greenstones on Eersteling No. 87 and the adjoining farms, their orientation being revealed by rows of low hills to which they give rise.

To the north of Yzerberg there are two horizons of arenaceous rocks, both dipping in the same direction. It is possible that this repetition may be due to complicated folding but the writer rather favours the view that they represent two distinct sedimentary horizons, since the northerly one lacks the conglomerate zone and is generally also finer-grained than the other.

On Snymansdrift No. 4 a change in the direction of strike of the sedimentary rocks takes place from north-west south-east to north-east south-west, this also being the trend of the rocks of Mount Maré. In this locality there is also evidence of an unconformity between the arenaceous rocks and the shale-quartzite horizon of Mount Maré. The latter, containing the middle ironstone near its base, disappears towards the south-west and cannot be definitely located close to the boundary fence of Hollandsdrift No. 113 and Snymansdrift No. 4. The lowermost ironstone zone also trends more or less at right angles to the strike of the arenaceous rocks up to the point where the latter are affected by the transverse fault. When travelling along the road from Pietersburg to Potgietersrust one notices, on looking towards the south-western extremity of Mount Maré, the unconformable relation between the arenaceous beds and the banded ironstone. It must be pointed out, however, that in one place in the area of the contact of the lowermost banded ironstone and the arenaceous beds, a knotted schist was encountered. Its presence, suggesting argillaceous rocks, would contradict the idea of an unconformity or transgressive relation between the arenaceous beds and the shales ; but shaly rocks are so commonly developed in unexpected positions that not much importance can be attributed to their local occurrence. It is, of course, also possible that the relationships are due to faulting, of which we have evidence in the general sheared nature of the rocks.

The pebbles in the conglomerate beds of the arenaceous horizon largely consist of banded ironstone and basic schist. This phenomenon, although not proving the presence of an unconformity in this particular locality, is nevertheless strongly in favour of it. A few granite pebbles have also been recognised in which the felspars are still perfectly fresh. This indicates that the material has not been transported over a great distance and also that during the deposition of certain beds hitherto regarded as belonging to the Swaziland system, granite outcrops were already in evidence.

In the north-eastern end of Mount Maré, complicated faulting is tentatively considered to have caused the strange present-day distribution of the rocks. It has been previously pointed out that the lowermost banded ironstone suddenly ends against the coarse sedimentary rocks and that this contact is considered to be tectonic in origin.

A knowledge of the original nature of the rocks that are now green schists will have an important bearing on the correct interpretation of the geological phenomena. It is doubtful whether sufficient detail on this point will ever be obtained from these highly altered pre-Cambrian rocks.

IV.—THE GOLD DEPOSITS.

Detailed Description.

In this section the main features of each gold occurrence will be given. Most of the localities once worked have been abandoned and a report on dilapidated excavations must necessarily be very disappointing. Information from private individuals has often, however, been of great assistance. The statistical section of the Division of the Government Mining Engineer supplied the figures from which the gold production in the past could be calculated, and also kindly put the few plans of the old workings, which are still in existence, at the author's disposal.

The auriferous deposits are of two kinds: Reef gold occurrences and alluvial deposits. The former consist of quartz reefs in the rocks of the Swaziland system and the Old Granite and mineralised fracture zones in the basic schists. The reefs are generally vertical or dip at a steep angle and usually conform more or less to the schistosity or the bedding planes of the enclosing rocks.

1. *The Witkop Gold Occurrence.*—On the farm Weltevreden No. 140 many trenches show that considerable prospecting work has been carried out on the southern slopes of the prominent vein quartz ridge known as Wit kop. In a drive connecting two shafts 230 yards south-east of the light-tower, amphibolitic rocks with quartz veins are said to give good values over a width of 23 feet.

The most southerly of the two shafts has been sunk on a vertical quartz reef, about 3 feet wide, containing oxidised ferruginous material. This reef appears quite promising, but does not extend far along the strike. There are, however, several small quartz veins in the vicinity and values are said to have been found along a strike of about 1,000 yards trending more or less in an east-westerly direction.

Apart from the amphibolitic rocks in the immediate neighbourhood of the shafts, the schists in this area are chloritic and serpentinous, and the conspicuous white vein quartz is generally barren.

No gold has been produced from this locality.

2. *A Quartz Vein in the Old Granite on the farm Palmietfontein No.* 101 yielded good values. It strikes at right angles to the general trend of the schists and appears to have stopped at the contact between the granite and the pre-granite rocks. When Hall visited the area, the mine was still being worked, and he has reported on it as follows: " The reef is a well-defined body of fresh white quartz dipping 50 to 60 degrees to the south-west and embedded in coarse fresh grey granite. On the east side it ends abruptly against soft clayey schists. As a rule it is only a single extremely well-defined body but at the 185 ft. level it passes off into stringers, when a soft clay film is found separating the main reef from the granitic footwall. The average width is 18 inches but on the 85 ft. level the reef sometimes expands from six inches to four feet in three to four yards. The gold content is extremely variable, averaging about 4 dwts. Those portions which consist of the purest white quartz contain very little gold. At the 45 ft. level a brownish red and very rich variation comes in, sometimes slightly honeycombed. Specks of very dirty gold may sometimes be seen but as a rule the reef consists of hungry white vein quartz. No associated minerals and practically no pyrites occur. Owing to the solid nature of the country rock little timbering is required, the mining being easy and clean." (3, p. 102.)

At a depth of about 200 feet the reef is said to have spread into a number of small veins accompanied by a flattening in the dip. The property is considered to be worked out.

Attention has also been drawn to a few acid veins in the granite on the farm Langgenoeg No. 1977. Although rich, they are too erratic and too small in extent to be worth exploiting.

Gold Production on the farm Palmietfontein No. 101.

	Tons of ore crushed.	Tons cyanided.	Gold recovered Fine ounces.
August 1907 June 1908	2,958		1,039·321
July 1908–June 1909	2,906		682·850
		1,218	27·000
July–October 1909	60		34·130
		1,583	69·740
1927	1,000		79·930
1928	480		88·380
1934 (working also on Langgenoeg 1977 and Roodepoort No. 88)	348		15·090
1935 (Ditto)	3,285		251·000
1936 (Ditto)	60		5·210
TOTAL	11,097	2,801	2,292·651*

* In addition during 1909, 36·220 ounces from by-products and during 1923 and 1932 7·38 and 6·280 ounces respectively from pannings.

3. *Knight's Pietersburg Gold Mine.*—A narrow strip of schists at the northerly contact of the granite on the farms Palmietfontein No. 101 and Langgenoeg No. 1977 has been mineralised along a considerable distance of strike as indicated on the map (Plate VII). It passes from the farm Langgenoeg No. 1977 into the farm Roodepoort No. 88 but it has not proved sufficiently rich to warrant exploitation. As can be seen in prospecting pits, oxides of iron in talcose schists constitute the reef. Quartz is scanty and talcose schists can be found along this line showing a trace in the pan without possessing noteworthy signs of mineralisation. Where this mineralised zone changes its strike in bending round a granite body[1] on the farm Roodepoort No. 88, the values improve, as shown by the presence of falling-in excavations and shafts leading to underground workings. A plan of the mine still in existence shows that in 1904 the property was developed on two levels, one at a depth of 100 feet and the other at 200 feet. The work was limited to driving and crosscutting. No records are available of the work carried out since then; it is said that work was stopped at depth on account of excessive water.

4. *The Northern Hope Mine* is situated south-west of a small granite intrusion. It is at present abandoned, but there is evidence to show that a curvature in the country rock constituted the site of the lode—a quartz-bearing reef in schist.

5. Another mineralised zone passes through the *Old Freda Mine* on the farm Roodepoort No. 88. At this particular locality there is not much to be seen at the surface except a few vertical shafts. According to a plan of the mine drawn up in 1915 a considerable amount of stoping has been done on the 100ft. level reaching as far as about 45 feet from the surface. One shaft goes down to a depth of 140 feet and a drive with two crosscuts are shown on this level but apparently no stoping was done. At present everything is under water.

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[1] The rock forms a massive outcrop and is an albitite, consisting almost entirely of albite with numerous blebs of pyrite. The latter mineral produces the reddish speckled appearance of the rock on weathered surfaces.

About 400 yards to the north-east of the Old Freda Mine along the probable strike of this mineralised zone, trending in an east-westerly direction there are three vertical reefs, two banded ironstones 45 yards apart with a mineralised zone between them. Considerable open stoping has been done on the latter, which is about 2½ feet thick and consists of quartz stringers in a chloritic schist. The partially collapsed walls of this working are reputed to cover the bodies of five native workers.

Gold Production on the farm Roodepoort No. 88.

	Tons of ore crushed.	Tons cyanided.	Gold recovered. Fine ounces.
1905–1906	2,359		152·970
1908 (to Jan. 1909)	2,369		444·986
1909–1910	211		121·420
		554	55·380
1911	1,435		282·595
1912	2,402		663·970
1913	3,387		598·090
		572	170·100
1914–1915	2,387		270·200
		1,751	259·710
1916 (working also on Langgenoeg No. 1977)	180		21·790
1917 (Ditto)	1,341		190·790
1921–1922	258		34·490
1923	2,868		351·130
1924	1,799		247·200
1925	765		200·340
1926	1,903		409·639
1927–1928	1,737		206·475
1931	2,555		215·000
1932	350		24·110
		420	7·450
1937 (up to Nov.)	109		7·340
TOTAL	28,415	3,297	4,935·175*

* In addition during 1914–15, 199·099 ounces and during 1936, 5·450 ounces from unknown quantities of ores.

6. At the *Lone Tree Mine* on the farm Wildebeestfontein No. 89 quartz veins in green schists were worked. The continuation of this zone into the farm Roodepoort No. 88 has recently attracted much attention and one quartz body on the latter farm carries very well. The values and the persistence and thickness of the reefs are, however, very variable. In contrast to other localities, the quartz in the reef carrying the highest values is slightly dark-coloured whereas elsewhere " likely " quartz is generally stained by oxides of iron.

Since the survey of this part was completed another lode has been struck at the north-eastern end of the old workings of the Lone Tree mine. It would appear that in this part the gold-bearing solutions rose along more than one fissure confined to a narrow zone. One may find that, within a few feet of one another one reef pinches out while another reaches its maximum development.

As with the other mines in this region the Lone Tree mine was only worked down to, or slightly below, the water level.

The granite contact is not exposed but the presence of the rock in an excavation close to the mine proves that it is not very far from the mineralised zone.

Gold Production on the farm Wildebeestfontein No. 89.

	Tons of ore crushed.	Tons cyanided.	Gold recovered. Fine ounces.
1907	631		101·028
		330	25·896
1908–1909	1,312		173·552
1936–1937	285		21·530
		2,076	74·300
TOTAL	2,228	2,406	396·306[1]

[1] In addition during 1936, 1·150 ounces from an unknown source.

7. *The Marabastad Goldfields.*[2]—The gold-bearing reefs of Mount Maré, generally known as the Marabastad goldfields, received much more attention about 1908 than at present. Hall's report on these occurrences consequently contains information which is no longer easily obtainable.

"The principle works on the farm Snymansdrift No. 4 are (1) No. 3 hill, near the northern part of which stands the battery, (2) No. 4 hill, a little east of the former and separated from it by a small poort, (3) No. 7 hill to the north of the two previous workings and identical with the principal ridge formed by the lowermost ironstone. The earlier workings are those of the last-named point. There are found at last three or four quartz reefs in the schist both interbedded and cutting across the formation. In the lower ironstone range (No. 7 hill) a reef occurs apparently interbedded at the base of the lowermost ironstone on the north side of the range and underlain by very hard greyish-green quartzitic slates. Its average width is 14 inches and its value about 8 dwts. In Nos. 3 and 4 hills the horizon is a little above the middle ironstone and above the horizon of the ottrelite and andalusite schists. The footwall of the reef in No. 3 hill is known locally as knotted schist but does not represent a metamorphic rock such as is usually implied by this term but is a kind of greenish sheared conglomerate, not unlike that found close to Brown's adit near the eastern end of Mount Maré with which the footwall of No. 3 reef may roughly be correlated. The hanging wall is a pale green more compact sheared sericitic quartzite with metamorphic tourmaline. This reef is interbedded and averages nine inches in width. In No. 4 hill are found two distinct quartz reefs, one of which is interbedded with schists, also resting on sheared conglomerates and is probably identical with that of No. 3 or Battery hill. The other cuts across the schistosity in a north-easterly direction, is much twisted about and may even be interbedded for short distances. A little above the horizon of the ottrelite schists on the Zandrivier Mynpacht (Mount Maré proper) occurs an old shaft some 70 feet deep at the bottom of which is a drive about 200 feet long, cutting across the strike towards the north. It exposes four interbedded reefs of which the most southerly near the shaft averages fourteen inches in width.

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[2] According to Hall the occurrences on the farms Eersteling No. 87, Waterval No. 211 and Vrischgewaagd No. 106 are generally also included. Nowadays, however, the Eersteling occurrence has become so prominent that it is generally referred to separately. It is also worthy of note that Marabastad is the railway station on the farm Zandrivier No. 139, Mount Maré is the mountain range on the same farm and the school farm has been called the Kuschke School Farm.

Elsewhere, numerous gold-bearing horizons of lesser importance are found along or near the Mount Maré range. Thus near the eastern corner of the farm Hollandsdrift occurs an interbedded quartz reef about 8 inches thick at the base of the uppermost ironstone band and underlain by red shales." (3, page 101.)

When the writer visited Mount Maré in 1937 the deposits on Hollandsdrift No. 113 and Snymansdrift No. 4 were no longer being exploited. Judging from the amount of work done at the different localities, the reef on No. 3 hill, described by Hall, has been the most productive. It is indicated on the map. On top of the hill the reef was stoped out to the surface over a width of about 18 inches. It occurs at the base of the arenaceous beds where they bend round towards the north-east. The footwall of the reef, as seen in an adit to the north of the hill, is a green phyllitic rock, whereas at the summit the reef occurs entirely in arenaceous beds so that the same horizon has not been absolutely retained.

It is doubtful whether the other localities mentioned by Hall on these farms have received more attention than mere prospecting.

Gold Production on the farm Snymansdrift No. 4.

	Tons of ore crushed.	Tons cyanided.	Gold recovered. Fine ounces.
July 1907–June 1908	8,768		4,246·610
July 1908–June 1909	7,628		2,043·380
July 1909–June 1910	7,162		1,830·560
1908–June 1910		7,380	549·340
July–Dec. 1910	513		208·620
		2,650	69·180
TOTAL	24,071	10,030	8,947·690

8. *The Deposits on the Mynpacht on Zandrivier No.* 139 were still being exploited in 1937. The reef, a crushed vein quartz very variable in thickness, was opened up in a number of localities on the southern dip slopes of Mount Maré (cf. Plate IV, photo 2). It is generally more or less conformable with the country rock, dipping at a variable but steep angle to the south and striking in a north-east south-westerly direction. The enclosing rock is the shale above the middle ironstone, but the hanging wall and the footwall often consist of entirely different rocks such as unaltered shale and a bluish quartzite. Slickensiding and tectonic breccias are well developed and even the quartz composing the reef has been changed from a coarse-grained hungry quartz to a rock composed of fractured quartz cemented by pulverised material. Coarse visible gold is very common especially along the shear planes in or at the contact of the reef. There is little doubt that the gold was introduced into the rock during the final stages of, or even subsequent to, the disturbances to which the quartz was subjected. Although the country rock as well as the reef is often very

PLATE IV.

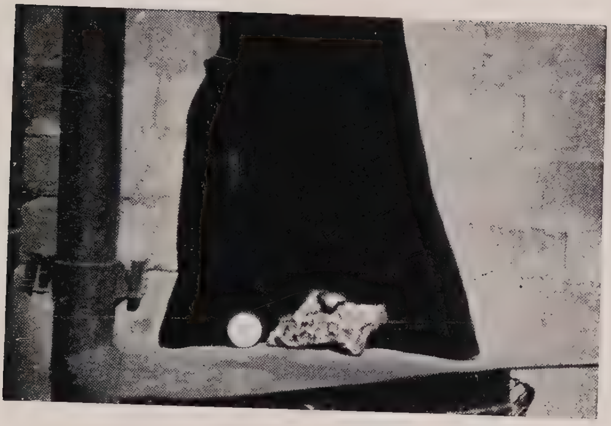

Photo : A. L. Barnard.

PHOTO 1: Gold Nugget found on Eersteling during 1936, compared with a golf ball.

PHOTO 2: Workings on the southern slopes of Mount Maré.

fresh, no sulphides could be recognised. It is said that towards the east arsenopyrite is occasionally encountered. The reef appears to be confined to an area which has suffered the most intense metamorphism in the whole of the region investigated. The andalusite schists occur in the same vicinity and sporadically at other localities. The presence of gold in this particular area is probably not connected with the intensity of the metamorphism but rather with the association of hard and soft rocks, which has resulted in a zone of weakness along which gold-bearing solutions migrated.

Close to the boundary fence between the farms Zandrivier No. 139 and Snymansdrift No. 4 a quartz body striking at a small angle to the country rock represents another deposit, to which attention has been directed in the past. The quartz as at present exposed is certainly not worth exploiting, as it is for the most part very white in colour. Probably only certain portions of the vein or its contact with the country rock were mineralised. The reef occurs more or less on the same horizon as the deposit already described from this farm.

The earliest workings also extend towards the north-eastern end of the mountain range. Several efforts were made to strike a gold-bearing reef in depth as is evidenced by the adits driven into the range from the low-lying southern side. Towards the basal portions of the horizon at which the gold occurs elsewhere on this farm a certain amount of open stoping has actually been done on an interbedded reef. The latter, varying from 2½ feet to 4 feet in thickness, consists of quartz stringers filling fractures in a green phyllite. It appears, however, as if the values occurred towards the upper contact of the reef. It is noteworthy that where the highest values existed, according to the amount of stoping done, the footwall of the reef is composed of knotted schist.

On Zandrivier No. 139, on the side of the creek coming from Wildebeestfontein No. 89 and opposite to the Kuschke School Farm, a reef more or less at the contact of the granite and the schists, but mainly in the former, was mined at one time. At present everything is in a dilapidated condition.

Gold Production on the farm Zandrivier No. 139.

	Tons of ore crushed.	Gold recovered Fine ounce .
1907-1909	1,258	539·208
1915	147	47·410
1916	815	141·580
1935 (including some done on Snymansdrift No. 4)	1,598	508·280
1936 (Ditto)	1,119	496·510
1937 up to May (Ditto)	118	75·560 (18·10 from clean-up of a dump.)
TOTAL	5,055	1,808·548

9. *The Waterval Gold Mine.*—Due to an irregular injection and many xenoliths of amphibolite in the granite, the boundary of the Swaziland system is not always sharply defined on the farm Waterval No. 211. It is in such a contact zone that the gold deposit is situated. The result is that, in adjacent excavations, the hanging wall or the footwall of the quartz vein, which is the gold-bearer, changes from schist to granite and vice versa. The reef is not clearly laid bare at the surface but, from exposures in a winze and also in a shaft, there is no reason to doubt that an enrichment in the gold content is associated either with a curvature in the reef or the junction of two reefs striking in different directions (cf. the map, Plate VI).

Gold Production on the farm Waterval No. 211.

	Tons of ore crushed.	Tons cyanided.	Gold recovered. Fine ounces.
1913	331		14·400
1916	561		35·020
1933–1934	938		66·520
1935	57		1·685
		370	22·561
TOTAL	1,887	370	140·186

10. *The Gold Deposits on the farm Eersteling No.* 87.—For purposes of reference certain localities had to be given definite names. These have been inserted on the map. (Plate VI).

Beginning in the west, the first deposits encountered are in the vicinity of the *Girlie Mine.* In this section there are two reefs known as the *Northern* and *Southern* reefs. The Northern reef is the gold carrier and is known to extend from the creek towards the east for some 600 feet. In places it has a thickness of two feet and consists of a quartz reef dipping towards the south at an angle of 48° with a mineralised zone in the hanging wall. On the level of the creek drives have been made for a distance of approximately 600 feet but since the rains of February, 1937, large portions of the mine have fallen in. Across the creek towards the west the reef continues and, at a point where it is joined by another reef coming from the north-east, highly payable ore is said to have been extracted. At this locality partially fallen-in opencast workings are the only records left. The last-mentioned reef had another rich shoot some 100 yards towards the north-east. Here there is almost certainly a sharp curve in the reef. After the geological survey of the area had been completed, further attention was paid to this locality and an inclined shaft which was put down exposed very rich sulphides at a depth of 60 to 70 feet. According to Mr. F. C. Partridge, Senior Mineralogist to the Geological Survey, to whom an ore-specimen was submitted for investigation, the metallic minerals present are arsenopyrite, pyrite and chalcopyrite. The arsenopyrite is the main constituent; pyrite is also common but considerably less in quantity than the arsenopyrite. There is very little chalcopyrite present.

The Southern reef, which represents one of the most important structural features in the region from the economic point of view, begins west of the Girlie mine. Here it is mainly a quartz reef, probably consisting of more than one member. No further work has been done beyond the prospecting stage.

Along the same line of strike at the Girlie mine the Southern reef has been opened up in a number of shallow winzes. The quartz has practically disappeared and the reef consists of oxides of iron disseminated through the basic rocks. Its gold content is however very low. More to the east an exceptionally rich shoot has been discovered and worked as the *Pienaar's Reef*. It is probably the continuation of the Southern reef. Phenomenal values were obtained in an opencast working on the eastern side of a small creek. A winze put down on the reef some 100 yards from the creek did not yield the same values, but drives towards the west again entered the ore shoot. Prospecting drives in the opposite direction showed a decrease in the gold content.

The Pienaar's reef, although fairly well defined, is characterised by a poverty in quartz. It dips towards the south at an angle of 55° and averages 4 feet in thickness but widens out in places to 11 feet. The reef matter consists of barren fragments of green schist in a highly mineralised zone, completely oxidised and friable. At the 200 ft. level sulphides appear, generally as small specks in the shattered ore material. In a polished section pyrite, chalcopyrite, and pyrrhotite can be recognised. The last-mentioned mineral contains very small flames of a highly reflecting mineral, which is probably arsenopyrite. A fine-grained fresh rock collected at the bottom drive, that is at a depth of about 200 feet, was seen under the microscope to be essentially a biotite schist. In addition to the dark mica it contains abundant calcite, mostly confined to thin veins associated with the sulphides, quartz, chlorite, sericite and an epidote mineral. At the 200 foot level calcite is encountered. Mining is difficult on account of strong supplies of water.

To the east of Pienaar's mine a reef, opened up in several small pits, mostly abandoned, resembles the Southern or Pienaar's reef. Close to the boundary fence of the farm Vrischgewaagd No. 100 a number of shafts are said to have been sunk on reefs carrying well, but up to date they have not been producing. The shafts of the old Fair Maid of Perth mine lie on the same line of strike and the mineralised zone continues into Waterval No. 211. Available information about the old Fair Maid of Perth shows that in 1896 only a few prospecting winzes had been put down but no further development was done.

Although on the farm Eersteling No. 87 bedding or schistosity planes are not well developed in the Swaziland system, it is evident that the Southern or Pienaar's reef is conformable with the strike of the country rocks. The general structure of the country is revealed by the presence of low hills running in lines from east to west. Although these structural lines can be gauged from the topography it is not always possible to tell which of the two hills on the one side of a valley is the direct continuation of one on the other side. In the vicinity of the gold deposits on the farm Eersteling No. 87 one row of hills disappears. Although faulting may be responsible for this phenomenon, there is not sufficient evidence to prove this.

The gold occurrences other than those associated with the Southern or Pienaar's reef are found in reefs trending at an angle to the structure of the country.

The Dog Shaft, for instance, leads to underground workings on a reef striking north and south with a steep westerly dip. From the Dog Shaft[1] towards the north a considerable amount of rock has been taken out on three levels, the lowest at a depth of 182 feet. The reef at this level varies in thickness from 3½ to 4½ feet. Towards the north there is a curvature in the reef which probably also divides into two. Collapsing walls of the earlier workings give evidence of the richness of the lode at this point. One reef continues towards the structural line of Pienaar's reef and is said to bear well in places. South of the Dog Shaft very little stoping has been done until a point is reached where another reef from the north-west—the so-called Spur reef—joins it. Further south quartz crops out conspicuously at the surface but the values seem to decrease.

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[1] A plan of the underground work until June 1914 is in existence, the most complete of all the earlier mining properties in the Pietersburg district.

Maltz's Mine is situated on a cross reef to the west of the Dog Shaft. It dips towards the north at an angle of 65°, unlike Pienaar's reef which has a southerly inclination. It is essentially a mineralised quartz reef but at a depth of about 70 feet the so-called " Blue Bar " below the quartz also bears in places. This body is a quartz-impregnated schist with occasional specks of sulphides. Its thickness is very variable. Calcite is associated with quartz in veinlike bodies in this rock. Otherwise the rock is very fine-grained and consists of minerals such as sericite and chlorite. Occasionally pleochroic biotite flakes can be recognised. At the outset a single polished section of the ore was prepared and this contained only pyrites. Mr. Partridge, however, drew the author's attention to the phenomenon that some of the pyrite grains vary slightly in their properties. Accordingly he had several sections of the ore polished and has reported on the results as follows :—

> " The ores consist largely of pyrite of which there appear to be two types. The one is interstitial to the earlier euhedral pyrite and, where in contact, can be seen to be definitely whiter. There is little difference, if any, in their hardness and both are sensibly isotropic. The pyrite of the earlier period appears to have a weak anisotopism, and arsenic, which is present in the ore in small quantities, is probably associated with this anomalously anisotropic type.
>
> Small amounts of cubanite and chalcopyrite are also present ; both replace early pyrite along minute cracks and irregular islands developing from them. In the material examined neither cubanite nor chalcopyrite show twinning nor exosolution lamellae and as they are intimately associated it would appear that the solutions which deposited these later sulphides were below 450°. They were probably nevertheless still high-temperature or hypothermal solutions."

Proceeding towards the west, Maltz's reef suddenly stops at a point close to the creek. There is little doubt, however, that the same mineralised zone continues on the other side of the creek. It has probably been slightly faulted or else the forces responsible for the fracture were released along a plane more or less parallel to Maltz's reef but at a slightly different horizon. In this section the reef was worked in early times and no records are obtainable of the work done underground. The result is that at present much difficulty is being experienced in opening up the property.

A considerable distance to the west of most of the workings on the farm Eersteling No. 87, prospecting was done on a reef to the north of a conspicious schist hill. This reef is a mineralised zone, apparently very irregular, in the schist ; in the vicinity a white quartz vein occurs.

Gold Production on the farm Eersteling No. 87.

	Tons of ore crushed.	Tons cyanided.	Gold recovered. Fine ounces.
1906–1907	—	790	125·585
1915	2,946	—	485·000
1916	3,489	—	544·279
		2,198	255·731
1917	3,428	—	437·340
		3,087	230·480
1918	2,751	—	403·580
		1,758	144·610
1919	1,051	—	277·510
1920	2,376	—	268·400
1921	1,877	—	278·100
1922 -1923	3,339	—	581·450
1924	1,155	—	92·250
1926	1,942	—	240·460
1927	2,224	—	365·040
1930	31	—	5·960
1931 (working also on Vrischgewaagd)	130	—	11·180
1932	3,907	—	1,144·958
1933–1934	11,534	—	1,696·141
		1,060	64·000
1935	4,569	—	719·862
		6,008	217·991
1936 (working also on a small scale on Vrischgewaagd No. 106)	3,319	8,465	790·088
1937 (up to November)	3,956	5,408	921·951
TOTAL	54,024	28,774	10,301·946

11. *The Gold Deposits on the farm Vrischgewaagd No.* 100.—Besides the east-west trending structural line of Pienaar's reef, passing through the northern part of the farm Vrischgewaagd No. 100, a cross reef is known to exist not far from the boundary fence between this farm and Eersteling No. 87. At the *Jewellershop* next to the road a rich shoot was discovered and worked out on this reef. It has been followed further to the south as quartz and mineralised schist, but it has, up to the present, not warranted further exploitation.

It may be mentioned that a short distance east of this reef is a very hungry quartz vein bearing occasional blebs of galena.

At *Malan's Workings* on the same farm attention was directed to a number of vertical quartz reefs in chlorite and amphibole schists. Although several carry traces of gold, no enrichment could be located in them and some disappear at a small depth. There are very many pure white quartz veins (buck reefs) in this part unaccompanied by any metallisation. Lit-par-lit injection of the schist by the granite is a very characteristic feature of this area.

South of the working just referred to, there are a few irregular quartz reefs, indicated on the map as *Le Roux's Property*. The irregularity in their behaviour—striking in different directions and probably also intersecting—suggests that there may be a concentration of ore in places, but the quartz itself has a very hungry appearance.

Near the boundary fence of Rietfontein No. 70 at *Clarke's Workings* quartz and mineralised schist have both attracted notice. One laminated reef consists of alternating thin bands of quartz and schist impregnated with oxides of iron. On the farm Rietfontein No. 70 the same reef yields fresh sulphides at a depth of 22 feet. There is no doubt that the quartz and the sulphides are of hypogene origin.

Gold Production on the farm Vrischgewaagd No. 100.

	Tons of ore crushed.	Gold recovered. Fine ounce .
1905	996	254·178
1908–1909	1,184	72·090
1914	143 (rubble)	9·920
1915	75 (rubble)	14·280
1920	35	5·390
1924–1925	1,143	111·350
1926	920	74·990
1936–1937	216	1·590
TOTAL	4,712	543·788*

* In addition 3·050 ounces from an unknown source.

12. Below the escarpment of the Black reef series on the farm *Rietfontein No.* 70, a very extensive prospecting scheme has been carried out on quartz veins interbedded with the schists. The enterprise has, however, proved a very great disappointment.

13. On the farm *Turffontein No.* 105 a few shafts have been put down on a thin banded ironstone which passes through this area. Although in the surface rubble good values are said to have been found, no reef could be discovered worthy of exploitation.

14. No reference has been made to many small occurrences but these present no new features and generally have not warranted more than a superficial scraping of the surface, as is the case with a few in the neighbourhood of the northern beacon of the farm Waterval No. 211.

In several localities shafts have been put down into the lowermost ironstone of Mount Maré, e.g., at the back of the Kuschke School Farm and also further to the south-west. There is no reason to doubt that gold may be associated with thin quartz stringers in the ironstone but prospecting has not led to any large scale development.

15. *Alluvial Deposits.*—The irregularity in the distribution of the gold in the deposits south of Pietersburg is not confined to the reef occurrences but also applies to the alluvial deposits, so that these gold fields on the whole attract not only the adventurous miner but also the alluvial digger.

A considerable amount of "digging" has been carried out on the farms Eersteling No. 87, Vrischgewaagd No. 100 and Waterval No. 211. The deposits have been worked irregularly at different times with the result that their present value can hardly be estimated. Only those occurrences which have actually been exploited are indicated on the map and it is clear that in general they represent the products of the reef gold deposits which have been spread out in the low-lying parts not far from their source (cf. the map, Plate VI). The bedrock is generally decomposed and hence soft and friable, so that it is ideal for breaking up and recovering the gold, which has made its way into fractures and joints. In other parts of the world many alluvial deposits with solid bedrock are found and much difficulty is experienced in extracting this gold which often represents a very high proportion of the total amount in the deposit.

A controversy prevails amongst the diggers as to whether they are dealing with eluvial or alluvial deposits. In many localities the bedrock is traversed by a number of fine quartz leaders and it is considered an established rule that the gold is associated with them. On the other hand it is obvious that the leaders act as barriers against which the transported gold would accumulate and would enter the bedrock to a variable extent, depending upon its grain size. In not a single case could the small quartz leaders be found to lead to definite reefs. They thin out and disappear at shallow depths.

In a few places, as on Vrischgewaagd No. 100 and on Eersteling No. 87, close to the boundary of Rietfontein No. 70, small deposits have been worked in a region with quartz veins in which the gold is probably eluvial. Elsewhere, as on the original outcrops of Maltz's reef which from its situation in a small depression is suitable for yielding eluvial gold, the deposits have been worked out and covered with waste.

Occasionally fairly large nuggets are found in the alluvial occurrences. The one shown on the photograph[1] yielded 76·1 ounces of gold and 6·25 ounces of silver and, as can be seen, has hardly been rounded (Plate IV, photo 1, facing page 26). The small nuggets, also, hardly ever show features suggesting transport by water. The gold has obviously not been carried over a considerable distance.

The exploitation of the more extensive alluvial occurrences on Eersteling No. 87 is also encouraged by the fact that water is obtainable from a permanent stream in the immediate vicinity.

Alluvial Gold Production on the farm Eersteling No. 87.

Year.	*Gold recovered.* *Fine ounces.*
1910	36·650
1911	14·800
1912	19·060
1913	7·720
1914	28·910
1915	0·510
1923	0·920
1926	12·890
1930	0·550
1931	74·530
1932	118·690
1933	449·130
1934	1,027·980
1935	490·810
1936	606·010
1937 (up to Nov.)	234·050
TOTAL	3,123·210

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[1] The photograph was placed at the author's disposal by Mr. A. L. Barnard of the staff of Barclay's Bank (D.C. & O.), Pietersburg branch. He is heartily thanked for his kindness in this connection.

GENERAL DISCUSSION.

In the account of the individual gold occurences a distinction has only been made into alluvial and reef gold deposits and the latter have been described as of two types, namely, quartz reefs and mineralised zones in the schist. Otherwise they have been treated according to their geographical distribution. Genetically they are considered to be closely related—*the metallisation is connected with the intrusion of the Old Granite.*

Although the deposits are associated with a great variety of rock types, no evidence could be recorded indicating that the composition of the enclosing rocks has a noticeable effect on the ore content. With regard to the Gwanda Gold Belt, the phenomenon observed by Tyndale-Biscoe (4, page 4), that there is a decided preference for the gold to occur in greenstone while serpentine is unfavourable, is probably to be ascribed to the physical properties of the serpentinous rocks in contrast to those of the greenstones. The former are almost certainly less susceptible to fracturing and to the formation of cavities than the latter. The experience of Hulin in this connection is that " in so far as different rocks may fracture in a more favourable or less favourable manner, the physical nature of the wall rocks may be an important modifying factor but beyond this it can hardly be considered to be of fundamental importance in controlling the location of ore shoots." (5, page 17.)

Decreasing temperature and pressure are considered to play a paramount part in the precipitation of the ore minerals but unfortunately their effects are difficult to recognise. It stands to reason that, in cases where the country rock has been extensively crushed and fractured, the solutions permeating through the rock fragments will be more rapidly cooled than when they rise in an open fissure with only two walls. In this way localisation of the ore may result.

Considered from a regional aspect the level to which the Old Granite batholiths in Southern Africa have been eroded represents the endobatholithic stage in their structure—" in plan the intruding granite forms the frame of the picture. The roof rocks are islands in the invading rocks. The deposits essentially are confined to the islands and to the granitic rock within a mile of the contact " (6, page 16). The map accompanying this report covers a large portion of such an island.

The confinement of a deposit to any one locality is largely a structural problem. With a view to indicating lines along which future prospecting is to be carried on, one need only summarise the salient features of the already known occurrences and indicate, where possible, analogous phenomena in other localities.

I.—*Several lodes are associated with curves in the contact between the schist and the granite:* for example, the Knight's Pietersburg gold mine and probably also the Northern Hope mine. Obviously in such localities open spaces have been created during the intrusion period of the granite, and along these, mineralising solutions could not only rise, but also accumulate and deposit their load. The southern contact on the farm Palmietfontein No. 101 represents such a curve on a fairly large scale. Although quartz veins are well developed at the " likely spot " they are barren (see also below under " buck reefs ").

Elsewhere no conspicuous features have been recognised indicating such a structure. It is, however, not improbable that the deposits in Mount Maré and at the Lone Tree mine represent fractures not actually at a bend in the formations but in the tension quarters resulting from such disturbances: in the Mount Maré region there is a conspicuous change in strike of the formation from north-east to almost north-west and on the farm Palmietfontein No. 101 the banded ironstone changes in trend from north-east to almost east-west.

The curving contacts indicated on the map in so many localities are mostly due to a gradual thinning out of a number of granite veins in the schist, without any noteworthy disturbance. Generally curved contacts of the schist cannot be readily recognised but on detailed prospecting in a particular locality such phenomena can be given careful attention.

II. *The gold-bearing reefs are associated with minor lines of fracture and movement.*—In any of the occurrences in the Mount Maré region there is ample evidence of movements having taken place between the hanging wall and the footwall and also portions of the reef. Slickensiding can often be observed with the direction of movement corresponding to the dip of the enclosing rocks. There is also little doubt that the reef at Pienaar's mine is a mineralised fracture zone. Arguing along these lines, special attention should be paid to the possibilities of enrichment along the most important fault zones. Apart from the fact, however, that the transverse fault extending from Mount Maré to beyond Yzerberg is post-Transvaal in age and accordingly younger than the mineralisation, Hulin has pointed out, no doubt correctly, that the " major fault lines may in general be expected to be less favourable sites for vein formation than other minor fissures due to the amount of movement the major lines have suffered and the consequent amount of inert and impermeable gouge developed therein." (5, page 21.)

III. *The gold is invariably associated with vein quartz or quartz-impregnated schist.*—The converse of this, however, is not always true. It is common knowledge to all gold prospectors that the pure white quartz veins, the so-called " buck reefs " are generally barren. To lay stress on this phenomenon as having a world-wide distribution, we quote the explanation given by Hulin: " Ore shoots are developed in these parts of the vein which are open to the passage of solutions at the time of the introduction of the valuable metallic minerals, conditions for deposition being favourable. In general the minerals of the common heavy metals, excepting for the moment the minerals of tin and tungsten, are introduced late in the sequence of mineralisation. The early introduced material of the vein quartz usually consists solely of barren quartz. This seals the existing vein fissures, forming barren quartz veins which remain barren unless subsequently reopened. Ore shoots are found where the early barren quartz veins are brecciated and reopened by intermineralisation fault movements at a time immediately preceding the advent of the metallising solutions. The location of ore shoots is thus directly dependent on favourable local structure of such nature that when affected by intermineralisation fault movements, brecciation and reopening of the vein are produced." (5, page 19).

The poverty of the prominent " buck reefs " is to be ascribed to the fact that the fissures have been sealed up so completely that subsequent movements could not bring about a reopening of the major buck reef zones and only affected the small quartz veins. It would appear as if regions with many buck reef occurrences have been avoided by the mineralising solutions; for example, on the farm Landsberghoek No. 280 and the adjacent farm Bloemhof No. 352 there are many quartz reefs and the granite-schist contact is very irregular. Yet no gold occurrences are known from this part. The same applies to many localities on the farms Roodepoort No. 88 and Palmietfontein No. 101. The gold occurrences in general are characterised by the absence of conspicuous quartz reefs. It is probable that the filling of the fractures by barren vein quartz imparted such a solidity to the environment that further fracturing during the actual mineralisation was no longer possible in the vicinity of the pronounced buck reefs.

It follows from the above reasoning that the fracturing which takes place during the mineralisation period need not follow earlier fracture zones but new fissures may form or inconspicuous ones may become prominent. As the ore-bearing solutions do not always deposit silica with the metals, mineralised zones may be found which contain a very small amount of quartz. Pienaar's reef on Eersteling No. 87 was probably largely formed during the metallising period and is consequently characterised by a small development of quartz.

Some of the buck reefs occur along conspicuous zones of weakness in the country rock; for example, on Zwartkrans No. 49, in two cases, quartz fills an original fracture at a point where lens-shaped xenolithic bodies of schist thin out completely. It may even be doubted whether in these two cases the sealing was so complete that a reopening was impossible.

An extraordinary amount of crushing has been suffered by the quartz of the gold occurrence on the Zandrivier Mynpacht. Elsewhere the disturbances have generally been such that movement planes developed either in the quartz veins or at their contact, along which the solutions then migrated and deposited the gold.

IV. *A concentration of gold has generally occurred at or in the vicinity of curves in the reefs and at the junction of two reefs.*—In some cases it is not clear with which of the two phenomena we are dealing. Thus at the Waterval gold mine there are indications of a bend in the reef although it is also possible that two reefs run together. The same applies to one of the occurrences west of the Girlie mine. To the north-east of the Dog Shaft there is a clear bend in the reef accompanied by an increase in the metallisation.

The two following examples are considered to indicate the phenomenon of two reefs running together: (i) West of the Girlie mine where the Northern reef is joined by another; (ii) the Spur reef joining that of the Dog Shaft.

The enrichment at intersections is generally believed to be due to a mixing of two solutions of different composition and a concomitant precipitation of the ore minerals. It may, however, also be imagined that, at the junction of two reefs, metallising solutions accumulate and remain stagnant for some time. During this period the precipitation of the metals takes place. Depending on the local structures, the solutions may only be able to accumulate at some distance from the actual junction of the two reefs and in this way the ore enrichment, although originally determined by such a phenomenon, does not take place at the actual junction. It is possible that the lode at the Jewellershop falls in this category (see map, Plate VI).

The concentration of ore in the shoot at Pienaar's mine is not easily explained. It may be that two reefs run together of which one is not yet exposed. Moreover, immediately to the west of the creek at Pienaar's mine, the reef has not yet been followed up to such an extent as to prove the absence of an irregularity along the strike.

With regard to Maltz's reef, we know that it is slightly faulted or ends abruptly before continuing to the west of the creek, so that an irregularity appears to be present. In addition, the reef at Maltz's mine and that at Pienaar's mine dip towards each other, so that the enrichment may be related to a structure in depth. On referring to the richness of the ore at Maltz's mine and at Pienaar's shoot to a structure in depth, one touches on *the problem of the persistence of ore to the lower levels*, and at the same time enters the field of speculation.

The account of the different gold occurences will show that practically no deposit has been worked below the water level. The reason generally given is that in the early days it was not possible to cope with the water. Other possible reasons are that the gold was no longer as free-milling in the sulphide zone as n the oxidised parts and that the ore became refractory to a certain extent. It is maintained that arsenopyrite is associated with the gold in depth at some of the deposits on Roodepoort No. 88. Arsenopyrite, chalcopyrite, cubanite and pyrrhotite, all of which are detrimental to the gold extraction, are also known to be present in some of the gold-bearing reefs on Eersteling No. 87.

Further factors favouring the exploitation of an ore-body in the oxidised zone are (i) the ease with which the oxidised ore in contrast to the solid rock n the sulphide zone is mined ; and (ii) an enrichment in the gold as the result of the removal of the gangue through leaching by percolating waters. " For gold-bearing veins the general rule of enrichment of the oxidised portion is based on reduction of volume of ore by weathering of sulphides and on the iberation of the gold contained in them. Solution and transportation of gold seem to be processes of subordinate importance." (Lindgren 7, pp. 44-45.)

Gold is one of the few elements which, owing to its insolubility in most olutions, does not migrate to any extent and the absolute gold content should not vary according to the state of oxidation of the ore, apart from a superficial enrichment of the upper few feet of the reef itself and of the eluvial rubble derived from it. As a matter of fact it is due to this insolubility of gold in contrast to silver that the bullion of alluvial gold possesses a greater purity than that of reef gold. " According to Emmons' investigations gold is soluble in uperficial waters only when free chlorine becomes liberated by the interaction of sulphuric acid, sodium chloride, and manganese oxide, a combination that must sometimes occur in ore deposits subject to oxidation : in the presence of oxidising pyrite some gold may therefore be taken into solution, as chloride ; but it would probably not remain long before encountering reducing substances." Lindgren 8, p. 237.)

The writer has observed that, in several cases, the underground water ushes out of open channels in the drives on the shoot at Pienaar's mine, a phenomenon which may have an important bearing on the persistence of the gold values here and elsewhere. This fact leads one to think that *a certain amount of mechanical transport by the water, of the fine gold especially, may be esponsible for an enrichment in the oxidised zone.* The comparatively impoverished material is continually being removed and the gold accumulates in the porous and honeycombed vein gouge. A mechanical impregnation of the material in the steeply inclined gold-bearing fissures may take place in the same way as, during the formation of placer deposits, the heavy constituents often ink to the bottom and even enter the bedrock along fissures and joints.

The above considerations lead to the conclusion that except for the influence f an infiltration from the surface downwards there is little reason to expect a onsiderable variation in the gold content at lower levels, even although we ave practically no information about the ore below the zone of weathering. t is to be emphasized, however, that as the nature of the deposits with regard o their continuation, thickness and gold content, is very variable along the rike, since these depend on so may factors they will almost certainly exhibit he same features in depth. The only advisable method of obtaining information ith regard to the possibilities of such deposits is by driving and shaft sinking, n other words, by actually exposing the reef. Except in a very few cases bore-ole results are not likely to give much valuable information.

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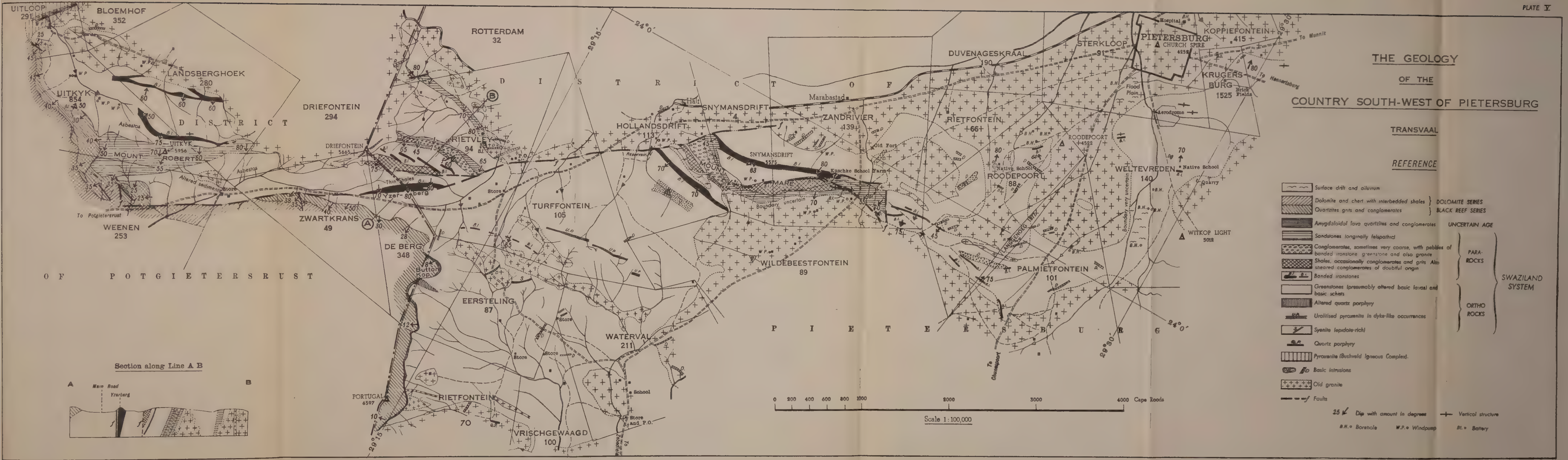


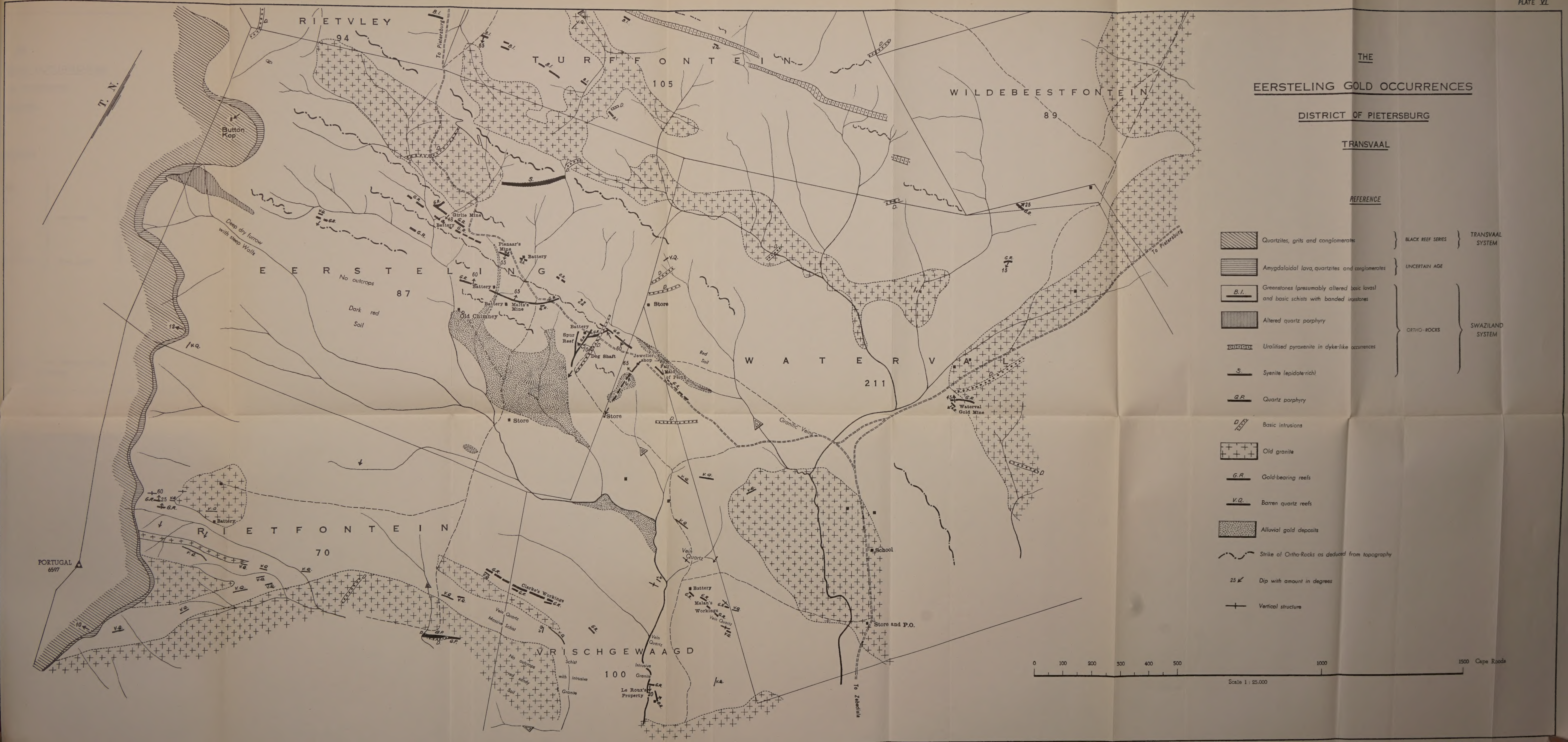
THE GEOLOGY

OF THE

COUNTRY SOUTH-WEST OF PIETERSBURG

TRANSVAAL

PLATE VI



THE

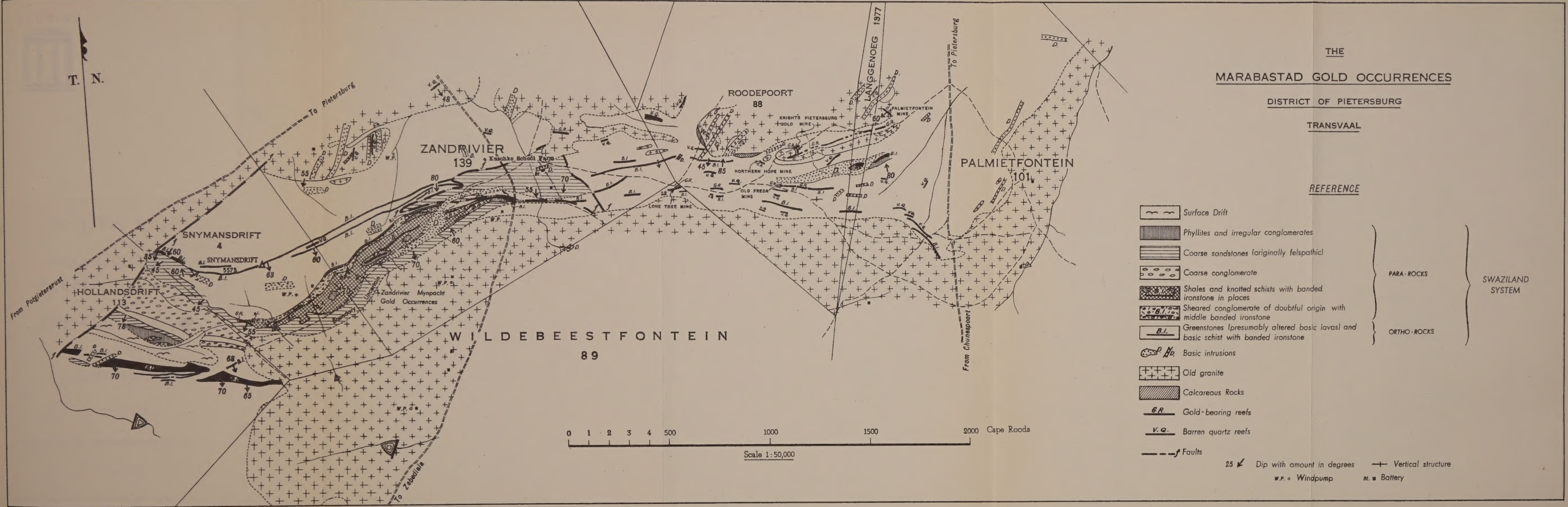
EERSTELING GOLD OCCURRENCES

DISTRICT OF PIETERSBURG

TRANSVAAL

REFERENCE

▨	Quartzites, grits and conglomerates	BLACK REEF SERIES	TRANSVAAL SYSTEM
▤	Amygdaloidal lava, quartzites and conglomerates	UNCERTAIN AGE	
B.I.	Greenstones (presumably altered basic lavas) and basic schists with banded ironstones	ORTHO-ROCKS	SWAZILAND SYSTEM
▥	Altered quartz porphyry		
▭	Uralitised pyroxenite in dyke-like occurrences		
S.	Syenite (epidote-rich)		
Q.P.	Quartz porphyry		
D.	Basic intrusions		
+	Old granite		
G.R.	Gold-bearing reefs		
V.Q.	Barren quartz reefs		
▒	Alluvial gold deposits		
⌒	Strike of Ortho-Rocks as deduced from topography		
25 ↙	Dip with amount in degrees		
┼	Vertical structure		



THE

MARABASTAD GOLD OCCURRENCES

DISTRICT OF PIETERSBURG

TRANSVAAL